Performance Evaluation and Capacity Planning of Corporate Networks: A Pilot Study of Methodologies and Trends

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ABSTRACT

During the past few years we have witnessed a staggering growth in computer networks. Internet and digital business have had a profound effect on our day-to-day lives. This paper discusses our findings in regards to the challenges that IT departments have had to face - in particular, that of ongoing network performance evaluation and capacity planning.

Our findings are the result of a pilot study that was conducted within a number of Christchurch based organisations. Issues such as user involvement, service level agreements, reactive or proactive planning have been addressed, as have tools, techniques and methodologies.

1. INTRODUCTION

The Internet has enabled many organisations to create new and exciting ways in which to conduct business with their partners and customers. As a result, the complexity and diversity of networking structures has exposed e-Business sites to greater risks - in particular that of increasing demand on the bandwidth and the security of business information.

The evaluation of network performance and capacity planning of corporate networks remains an ongoing problem for IT departments. Traditionally, planning for corporate networks has been reactive, some of the reasons being:

- Difficulty in gathering the data that was needed to determine the traffic flow over IP networks
- Corporate executives (until recently) viewing IT as a maintenance and cost centre
- Inadequate computer network performance being only one of the immediate risks executives face today
- Capacity planners not always communicating the benefits of managing network performance in managerial terms.

This has meant IT departments have addressed problems only after complaints have been received regarding slow response times. Considering the rapid changes with regards to global networking,

this reactive way of thinking needs to shift to that of strategic planning.

For this study, nine Christchurch based organisations from various industries (including education, government, service, manufacturing and technology) were considered.

2. CAPACITY PLANNING

2.1 Introduction

The best analogy for describing capacity planning would be that of building a road system. It is essential to know who would use which routes, how heavy the traffic can be, the trips' starting point, their destinations and so forth. If a network of roads is not planned well, traffic jams will occur and the road users will experience delays. On the other hand, if there are redundant lanes, the network will be under utilised.

Capacity planning can be defined as the process of determining and planning future resource requirements of a computer network, in particular that of bandwidth and key communication hardware. Benefits of capacity planning include:

- Improved network service levels (increased user satisfaction)
- Reduced network downtime and cost
- Improved network infrastructure to support current and future needs.

2.2 Methodologies, Models and Tools

2.2.1 Performance Evaluation

A variety of tools have been used in different cases to evaluate the performance of computer networks. Depending on the complexity of a network, one (or combination) of these techniques may be considered, including:

- Standard queuing models eg. M/M/C
- Mathematical models eg. Markovian Analysis, Throughput-Traffic Analysis and Equilibrium Point Analysis
- Computer Simulation - today, there are a large number of simulation packages available, that can model various applications, including computer networks.

Many network operating systems provide system managers with tools to evaluate day-to-day performance of networks.

2.2.2 Capacity Planning Models

A number of models for capacity planning have been developed, including:

- Concord Approach
- Microsoft's approach to capacity planning and network optimisation
- IBM's network capacity planning techniques.

These models all outline the steps that are involved in the capacity planning process. Several tasks, namely traffic analysis, workload characterisation, workload analysis and traffic projection seem to be the common components of these models.

3. STUDY OF TRENDS

A number of questions in regards to network performance monitoring and capacity planning were considered. A summary of the responses to some of the questions has been addressed in the following sections.

3.1 Monitoring Network Performance

Although the interpretation of the term "network performance" varied from company to company, they all consider this to be a very important component of network management. They expressed different reasons for monitoring network performance, which included:

- Determining the changes needed to improve the performance of the network
- Monitoring the servers, the internet links and the failures of network components
- Tracing and documenting problems before and after they occur
- Making balanced decisions regarding network improvements
- Planning for future
- Setting benchmarks for performance measures.

In conclusion, few firms raised the issue of long term and capacity planning as being a key goal for performance monitoring. The focus appeared to be

on the day-to-day operations of the network.

3.2 Performance Measures

Various performance measures included:

- User satisfaction (response time, speed of information or file transfer)
- Network uptime, availability, and reliability
- Number of nodes that are available and active in a sub-net
- Utilisation of core switches
- Queue lengths - various networking hardware
- Network outage type
- Security.

In general, some firms could not quantify some of these parameters - that is to say, they were not easily measurable or there was little or no historic data for comparison. Furthermore, there is still the issue of exactly how a network or IT manager would define the term “network performance” - for instance, security was mentioned.

3.3 Collecting Relevant Data

Most companies did not have a formal schedule for collecting data - instead, they appeared to monitor their switches, hubs and servers on an ad hoc basis or when they experienced problems.

Data that was collected for performance monitoring and capacity planning included:

- Internet traffic
- Types of network errors (help desk records)
- Average disk queue length vs. time of day
- Percent disk access time vs. time of day
- Average disk bytes transfer vs. time of day
- Interrupts per second vs. time of day
- Page fault per second memory vs. time of day
- Disk usage (by a user).

Once again, there seems to be some emphasis on the performance of a limited number of hardware components (eg. disk, server, CPU).

With regards to the frequency of data collection, most companies adopted a very unstructured approach - that is to say, there was no formal schedule for collecting and analysing data unless a problem was detected. Those who collected data according to a schedule, did so on a monthly basis.

3.4 Partnership with Business Units

Only two companies had a formal Service Level or Technology Partnership Agreement. The acceptable level of performance agreed upon varied from company to company. Examples of benchmarks for satisfactory performance include:

- Resolving 90% of critical faults within an hour
- Printing customers’ receipts in no more than 15 seconds
- Network uptime of 98-99% during core hours
- Responding to and resolving problems that are reported during class times within 5 minutes.

The companies that were approached had very little information about how they were keeping up with the benchmarks as set within their agreements with business units.

3.5 Factors Influencing Network Performance

Responses varied significantly. Parameters that were perceived to be influencing network performance, included:

- Computer viruses and bugs
- Software problems (incompatible software, new software that cannot be supported)
- Slow hardware components (workstations, switches, routers)
- Human error (user training, users’ ability to drive applications and users changing configurations by mistake)
- Accessing large applications over slow WAN links
- Corrupt databases or lack of disk space
- Hardware fault (faulty network interface cards, faulty connectors, condition of cables)
- Sudden major changes in the network without adequate network testing

- Insufficient network bandwidth for sustaining network demands
- High traffic loads.

It appears hardware, links and bandwidth are not the only concerns for network managers regarding network performance. Many perceived network management processes and the way in which users utilised the network to also be contributing factors.

3.6 Resolving Potential Problems

Most of the actions companies undertook for problem solving and future proofing of their networks focussed on infrastructure improvements - some of which are discussed here.

3.6.1 Upgrade of Bandwidth or Cable Types - including:

- Upgrading the network from 10Mbps to 100Mbps Ethernet
- Upgrading 100Mbps Ethernet with Gigabit Ethernet
- Replacing Cat3 cables with Cat5 cables
- Replacing slower WAN technologies with ATM 155Mbps
- Connecting some of the servers to the Gigabit fibre between the buildings.

3.6.2 Upgrade of Hardware Components - including:

- Replacing old workstations, servers, hubs, switchers and routers
- Service agreements with a third party vendor (to periodically replace equipment)
- Putting in place fault tolerance equipment and introducing redundancies where critical networking components are concerned (eg. switches)
- Replacing hubs with either switches or many smaller 10/100Mbps switches (for flexibility).

3.6.3 Reconfiguration of the Network - including:

- Arranging the smaller networks into VLANs
- Identifying the high use users and separating their servers from low use users
- Where possible, installing large applications on local hard drives, so as to avoid unnecessary network traffic
- Analysing network traffic where the bottlenecks occur and identifying strategies for reducing traffic
- Introducing sub-nets to re-organise groups of users (eg. splitting the network into areas of responsibilities).

3.6.4 Improving the Network Management Process - by:

- Standardising the workstation, so as to manage user expectations and timely <bi> resolution to application problems
- Documenting faults and errors for future reference
- Putting in place thorough change management and testing procedures
- Monitoring the results of implementing changes so as to measure the effectiveness of solutions
- Improving communication with users so as to keep them up-to-date with developments
- Installing and utilising monitoring tools, where appropriate (eg. in switches)
- Improving network security management (eg. installing and configuring firewalls, proactive risk analysis and planning, virus scanning information on an ongoing basis)
- Identifying core business functions and services so as to avoid growing the network unnecessarily.

3.7 Network Monitoring Tools

The companies named a variety of network performance monitoring tools including:

Compaq Insight Manager

- MRTG
- Help Desk records of network faults
- Cisco Works 2000
- Disk Space Quota Server
- NT Network Monitor and Performance Monitor (NT Servers)
- SNMPC
- Orcallator
- Big Brother
- Saint - snoop for security
- UNIX based tools.

None of the companies approached had a formal methodology for capacity planning in place.

4. CONCLUSIONS

The key objectives of this study were to:

- verify the key issues concerning network performance monitoring, analysis and capacity planning - that need to be considered and investigated in the future
- establish a first impression of trends, methodologies and practices.

In general, most IT departments seem to be spending a considerable amount of time in managing their day-to-day operations - having limited or no time available for long term planning. Few firms had a strategic approach to network capacity planning.

The participating firms had various interpretations of the term "network performance" - some even named security. We feel it important that for any future studies, this term is clearly defined so as to distinguish network performance from that of availability, reliability or security.

Even though many had identified various performance measures, some were unable to quantify these parameters. A great deal of emphasis was placed on the performance of hardware components such as disks, servers, CPUs and so forth.

Most companies took a very unstructured approach to collecting performance data. They either had no agreement concerning business units' requirements or had very little information about how they were keeping up with the network performance benchmarks as set by users.

There is little evidence of a structured approach to capacity planning - none of the companies had a formal methodology for capacity planning in place. This may not necessarily pose a problem, as the approach to capacity planing needs to be considered on a case by case basis.

Some companies identified the network management process, user training and the ways in which they utilise the network as being significant contributing factors to network performance.

We hope to be able to use the outcome of this research in order to fine-tune the issues that need to be further investigated and to possibly conduct a later study using a larger sample.

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REFERENCES

Asgarkhani, M. (1990) "A TDMA-Reservation System with Multi-message Buffering Characteristics". Proceedings of INFOCOM-90, Singapore

Asgarkhani, M. and Pawlikowski, K. (1989) "Simulation Studies of Mixed Traffic on a Satellite Network Using a TDMA-Reservation Protocol", Proceedings of the 8th International Phoenix Conference on Computers and Communications (IPCCC)

Asgarkhani, M. (1988) "Analysis of Multiple Access Communication Protocols: A Survey of Methods", Technical Report COSC 4/87-University of Canterbury.

Atkins, J. and Norris, M. (1999) "Total Area Networking". John Wiley & Sons

Baron, Anthony, (Accessed Jan 2001), Strategies in Network Capacity Planning and Network Optimisation - AB Pound Co. http://www.microsoft.com/technet/winnt/winntas/technote/ImplemntIntegra/ntopt3.asp

Cisco Systems (Accessed Dec 2000) "CiscoWorks2000-A Family of Network Management Solutions". http://www.cisco.com/warp/public/cc/pd/wr2k/prodlit/index.shtml

Compaq, (Accessed Dec 2000) "Compaq Insight Manager - Systems Management". http://www5.compaq.com/pro...rvers/management/cim49-description.htm

Concord Communications, (Accessed Jan 2001), Effective Capacity planning for the Enterprise Network http://www.concord.com/resctr/white/effective.html

Fingar, P. , Kumar, H. and Sharma, T. (2000) "Enterprise E-Commerce". Meghan Kiffer Press.

Menasce, D.A. , Almedia, V.A.F. (2000) "Scaling for E-Business". Prentice Hall

Monarch Information Networks Inc. (Accessed Feb 2000) "Capacity planning and network analysis using computer simulation techniques". http://www.monarch-info.com/

Nametka, William, (Accessed Jan 2001), Network performance and capacity planning - Techniques for an e-business world http://www1.ibm.com/services/its/us/pmcpnametka730final.html

Scholl, F. (2001) "Capacity Planning: When and Why". Monarch Information Networks http://www.monarch-info.com/capplan.html

Scholl, F. (2001) "Multimedia Networking Planning Guide ". Monarch Information Networks http://www.monarch-info.com/mmplan.html

Sniffer Technologies , (Accessed Feb 2001) "Network monitoring, analysis, reporting and capacity planning tools". Network Associates - http://www.